gives the results of his observations of Phœbe, the ninth satellite of Saturn, made with the 40-inch on July 24 and 29. The satellite was about 1m. in R.A. and 6′ in declination from the planet, and had a magnitude of 16·5; at times it appeared hazy. The observations give the following corrections, taken (observed-calculated), to Dr. Ross's ephemeris:—

	m. s.	′ ″
July 24	−0 0·93	+0 3·5
29	−0 0·87	+0 2·9

ENGINEERING AT THE BRITISH ASSOCIATION.

IN his presidential address to the section, Dr. Ewing dealt with certain aspects of the inner structure of metals and the manner in which they yield under strain, and he made a notable departure from the usual custom of such addresses by illustrating his speculations by experiments and by models in order to demonstrate his ideas as to the processes of crystal building.

After the presidential address a paper was read by Major W. E. Edwards, R.A., on modern armour and its attack. The author first gave a very complete and useful history of the application of armour to ships and forts, and then explained in detail the elaborate and costly processes through which the material passes, from the casting of the steel ingot to the completion of the plate. The second part of the paper dealt with the attack of armour and the various ways in which a plate may yield, and the influence of the cap in reducing the resisting power of hard-faced plates. In the discussion Sir William White expressed the opinion that British armour-plate makers had introduced many of the more important improvements in the resisting power of armour-plates, and that eventually the 6-inch gun would be chiefly used for defence against torpedo craft.

The first paper on Friday, August 3, was on the removal of dust and smoke from chimney gases, by Messrs. S. H. Davies and F. G. Fryer. The paper dealt with an ingenious plant the authors have designed and fitted up at the cocoa works of Messrs. Rowntree and Co. for thoroughly washing the smoke, and for removing from it the whole of the grit and dust and practically all the sulphur acids. Members of the section had an opportunity later on of seeing this plant in operation; it certainly thoroughly effects the purposes for which it was installed, and it might certainly be adopted with advantage in many factories where a cheap and plentiful supply of water is available.

In the next paper, on standardisation in British engineering practice, Sir John Wolfe-Barry gave an account of the admirable work which has been carried out by the Engineering Standards Committee since its first institution in 1901 at the instance of Sir John Wolfe-Barry himself. There are now thirty-six subcommittees with 260 members dealing with some thirty different branches of the work. The work of the committee has been invaluable both to manufacturers and to engineers, and the publications of the committee are indispensable to all engineers.

Dr. Ewing has during recent years done much valuable research work on the crystalline structure of metals, both in a strained and in an unstrained state, and it was only natural that there should be several papers on this important branch of the subject of the strength of materials. Mr. W. Rosenhain dealt with the deformation and fracture of iron and steel, and his paper was illustrated by a number of beautiful lantern slides. The author of this paper has done such admirable work in the microscopic study of the crystalline structure of metals that everything he has to say on this subject is sure to be of value. In his latest researches he has by a most ingenious method been able to study the crystalline structure of the actual fracture itself in broken test-pieces. The second paper on this subject of the crystalline structure of metals was by Mr. J. E. Stead, and dealt with segregation in steel ingots and its effect in modifying the mechanical properties of steel. To all those concerned either with the manufacture or with the employment of steel in industrial operations this paper was most valuable, for the author had brought together a large amount of information previously scattered in the pages of various publications. The microscopic study of the crystalline structure of different portions of steel ingots is rapidly changing the views of engineers in regard to many important problems in connection with the life of steel rails, and there is no question that the microscope now plays as important a part in the laboratory of the metallurgist as in that of the biologist.

Dr. H. C. H. Carpenter next read his paper on structural changes in nickel wire at high temperatures; this research, carried out at the National Physical Laboratory, was intended to throw light on the fact that fundamental changes occur in the mechanical properties of nickel wire used as the heating coil of an electrically-heated porcelain tube-furnace. Here again the microscope was the chief instrument in the research, and the study of the crystalline structure of the wires showed, the author suggested, that wire intended for electrical heating should be as free from gases as possible. A paper by Mr. W. Taylor describing a magnetic indicator of temperature for hardening steel concluded the day's proceedings.

On Saturday, August 4, the section paid a visit of inspection to the Roundhills Reservoir of the Harrogate Corporation. The dam, a masonry one, will, when completed, be 125 feet in height above the river bed, and members of the section were fortunate enough to see the work when the more difficult operations of such an undertaking were just in their most interesting condition.

On Monday, August 6, the first paper read was by Prof. Hudson Beare, on the new engineering laboratories of the University of Edinburgh and their equipment; the author pointed out that he had made special provision in these new laboratories for experimental work of an advanced character on the strength of materials and on hydraulics. At the conclusion of the discussion of this paper Sir W. H. Preece read a communication on glow lamps up to date, and the grading of voltages, in which he strongly advocated that steps should be taken to secure uniformity of practice in regard to regulation of voltage in connection with the distribution of electrical energy, and also in regard to the grading of carbon filament glow lamps; in the latter part of the paper data were given to show how poor in quality were many of the lamps on the English market. In the discussion on this paper Colonel Crompton directed attention to the fact that only a comparatively small proportion of lamps was used in private houses in America, while in this country the proportion was large; he also pointed out that the demand for electric current for power and for heating was now becoming a very important factor in the working of central stations.

In a paper on the advent of single-phase electric traction, Mr. C. F. Jenkin directed attention to the rapid advance of electric traction on railways, and pointed out its advantages. He pointed out that the real advantage of electrification was that it would make the line pay better. Mr. Jenkin then dealt with the two alternative systems—alternating current transmission, continuous current distribution with low-tension third rail, and alternating current transmission with high-tension trolley wire; he was of opinion that the latter method had very great advantages, and he advocated also single-phase instead of three-phase currents.

The business of the section for this day concluded with a paper by Mr. A. J. Martin on a general supply of gas for light, heat, and power production. Mr. Martin pointed out that the main obstacle to the general use of gas for purposes other than lighting was its cost, and that the chief causes of this high cost were the standards of illuminating value to which gas has to conform and the high prices paid for coal. At the present day both natural gas and coal gas have been piped in America to great distances (in the case of natural gas to 200 miles) with success, and Mr. Martin was of opinion that it would be perfectly feasible to generate gas cheaply at large works in the centre of our coalfields, and then to convey it under pressure to all our large cities for manufacturing and heating purposes.

In the course of the afternoon many members of the section took part in an excursion to Middlesbrough to visit

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the works of the Cargo Fleet Iron Co., Ltd. The whole of the plant at these works has been recently remodelled and fitted with the latest labour-saving devices and plant for recovery of by-products; the Talbot continuous steel process, which was introduced to the notice of English metallurgists only in 1900, has been adopted, and at the Cargo Fleet Works each of the three furnaces holds about 175 tons of molten steel.

On Tuesday, August 7, the section began its proceedings with a paper by Prof. W. E. Dalby on experiments illustrating the balancing of engines. The beautiful working models which Prof. Dalby has designed to illustrate the principles which underlie the problem of balancing various types of engines were shown in operation, and, as the president remarked during the discussion, it was a pity that the London County Council had not made use of the author's services in this field of engineering research before it began the design of a large generating station not half a mile away from Greenwich Observatory.

Mr. G. Stoney then read a paper on recent advances in steam turbines, land and marine. The figures given by the author showed how wonderful had been the advance since Mr. C. A. Parsons built his first turbo-dynamo of about 10 h.p. in 1884; at the present time 6000 kw. generators are in course of construction, while turbines of 10,000 kw. are proposed for the great power scheme to supply electric energy in bulk for London. The use of large turbine blowing engines in metallurgical work has also rapidly developed during the past three or four years, while for marine purposes the total horse-power of turbines, either completed or on order, now approaches 1,000,000. Mr. Stoney also described the "vacuum augmenter," a device for increasing the vacuum in the condenser without increasing unduly the volume of the circulating water by the use of a steam jet placed in a contracted pipe between the condenser and the air pump, which compresses the air and vapour from the condenser and delivers it to the air pump through a small auxiliary condenser.

The next paper was by Mr. J. Smith, on an application of stream-line apparatus to the determination of the direction and approximate magnitude of the principal stresses in certain portions of the structure of ships; this valuable paper was, the president stated, one of the first fruits of the laboratory of the Royal Naval College at Greenwich. The author showed that a strain diagram of the deck of a ship very closely approximated to the stream-line shown by Prof. Hele-Shaw's well-known apparatus, in which a very thin film of water is compelled to flow between two sheets of glass.

In the afternoon the section had a joint meeting with the physical and educational sections, and a discussion on the teaching of mechanics was opened by a paper by Mr. C. E. Ashford, headmaster of the Royal Naval College, Dartmouth. In his paper Mr. Ashford pointed out that there was a serious danger that school science might become as academic as classics, and he directed attention to the absolute necessity of employing for laboratory experimental work, not toys, but apparatus such as screw-jacks, Weston's blocks, &c., and also to the great need of experiments for showing the phenomena of kinetics; several new pieces of apparatus designed for this purpose by the staff at the college were described and illustrated.

Wednesday, August 8, the last day of the meeting, was an unusually busy one for the section; no fewer than six papers were dealt with. Prof. Ashcroft described, and showed in operation, the Central Technical College lecture table testing machine, an exceedingly ingenious and beautiful piece of apparatus; Prof. Ashcroft has adopted, with, however, considerable simplifications, the plan first devised by Prof. Kennedy, of using a "spring bar" to measure the loads upon the specimen under test, and to give one of the two necessary motions to the recording apparatus, thus overcoming the difficulties unavoidable when an attempt is made to keep the steelyard of the testing machine floating during the final drawing-down stage prior to fracture.

The next paper was one by Prof. J. B. Henderson, on recent advances in our knowledge of radiation phenomena and their bearing on the optical measurement of temperature. After discussing the four laws of radiation from an ideal black body, the author dealt with pyrometers based on these laws, such as Féry's, and the optical thermometer of Holborn and Kurlbaum.

Mr. S. Cowper Coles read a paper on electropositive coatings for the protection of iron and steel from corrosion, and showed a number of beautiful examples of electro-deposition. In the discussion Colonel Crompton stated that the processes invented by the author had solved a very difficult problem in connection with the piston rods of steam engines using very high-pressure steam, for it was now possible to give these rods a very hard, incorrodible surface without any sacrifice of strength.

In a paper on suction-gas plants, Prof. Dalby dealt with the principles underlying the design of such plants, and then described a number of plants which were entered for the recent trials in connection with the Royal Agricultural Society's show at Derby, and the methods of starting such plants. In reply to the discussion, Prof. Dalby stated that a 15 h.p. engine would use about 0·7 lb. anthracite coal per B.H.P. during running, or, if allowance is made for lighting up and standing by, about 1·0 lb. per B.H.P. hour.

Mr. W. A. Scoble, in a paper on the strength and behaviour of ductile materials under combined stress, described the results of a series of tests of steel bars with a distribution similar to that which occurs most frequently in practice, as obtained under combined bending and twisting; the experiments showed conclusively that the maximum principal stress and the maximum shear both varied through a wide range, the point used as a criterion of strength being the yield point.

The section concluded its business with the reading of a paper by Mr. D. Mackenzie, on waterproof roads as a solution of the dust problem. The various processes at present in use were described and their deficiencies pointed out. Tar alone was most unsatisfactory; at the end of twelve months it had entirely disappeared; the best material, he considered, was "tarmac," made from blast-furnace slag broken when hot and immediately immersed in hot tar; only forge pig slag should be used for this purpose.

It was a great pleasure to see the section so well attended, especially when it is remembered that the early days of the meeting clashed with the summer meeting of the Institution of Mechanical Engineers. No doubt much of the increased interest shown in the work of the section was due to the personal popularity of its distinguished president.

T. H. B.

EDUCATION AT THE BRITISH ASSOCIATION.

AMONG the "growing points" mentioned by Prof. M. E. Sadler in his address were the keenness of intelligent workmen to make the elementary schools better, the demand by adult workers for an education touched by imagination, humanity, and civic idealism, the encouragement of education by employers of labour, educational experiments carefully planned and systematically watched (*e.g.* in practical courses of study and corporal training in higher elementary schools for ages twelve to fifteen, and in the actual results of postponing the beginning of Latin until twelve years of age), and the need for continuation schools to check the drift into the physical and intellectual disorder of the unemployed. A full report of Prof. Sadler's address appears in the *School World* for September.

The list of schools and other institutions to which visits had been arranged included the Yorkshire School for the Blind, the classes in domestic economy for employees at Messrs. Rowntree's Cocoa Works, the British Botanical Association, with its extensive arrangements for the supply of botanical material, and two hospitals for the insane, the latter typifying the help which the schools may expect to receive from all contributions to mental science.

Health at School and *Physical Education* are topics which seem amenable to scientific treatment, and as such were very properly placed in the forefront of the programme. Sir Edward Brabrook presented the report on the conditions of health essential to the carrying on of the work of instruction in schools. This report deals with hearing,

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